WHAT IS ENTOMOLOGY

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What is Entomology? Webster says "Entomology is the department of Zoology that treats of insects; also a treatise on that subject." How does the particular department of Zoology referred to treat of insects? Treating of insects takes on many forms. It has many ramifications. It affects many people. It affects the health, the comfort, the well-being and fortunes of as many individuals in the world as perhaps any other applied science.

In species and kinds insects outnumber most if not all groups of living organisms. There are known more than seven hundred thousand kinds of described and named insects in the world. There are seventy-five thousand kinds so reported from North America north of Mexico. Of the seventy-five thousand kinds in North America there are estimated to be six thousand five hundred kinds of insects which are so injurious to agriculture in the United States that records of their occurrence are consistently reported to the Insect Pest Survey. It is obvious therefore that while entomology treats of insects, an entomologist can in reason only treat of a comparatively few species of insects. In schools the teachers can only teach the students the principles of the science and general fundamentals of insect structure, classification, physiology, habits and general distribution, leaving the student to specialize in the group of insects or branch of entomological work desired after graduation in the securing of degrees, in teaching, or in employment.

First in our work we must know what insects are and taxonomy is really one of the important points in treating of insects. The study and interpretation of structural characters for the purpose of classification and identification have a most important place in the science of entomology. For example, the species of Cochliomyia look much alike, particularly is that true of the forms commonly called screw worms. Cushing while working on this group with Patten in England found that what had been considered as one form, _Cochliomyia macellaria_, was really two species readily distinguished by structural differences. Later studies showed that their newly-described americana is the primary pest, the one which feeds on living tissue. This, although complicating the whole screwworm problem in a certain sense, simplified it in other ways and demonstrated again the value of taxonomic studies. Such studies make it possible to differentiate control

measures in the field, to properly dispose of infested shipments moving in commerce, and to appropriately apply quarantine measures.

Life history studies and studies in the laboratory and in the field to find out how the insect lives, how it propagates, how it feeds, how it damages or benefits crops or food or materials, teach us not only about the insect but what to do about it, a large part of the program of treating of insects. After several years of experiments in the effort to control wireworms, the immature form of the click beetle, physiological studies in connection with the life history studies developed that the particular poisons being used were not being taken into the system by the insect but were being thrown out before reaching the stomach.

Spraying with lead arsenate has long been a standard form of control of insects that bite and chew. Until the human health hazard involved in the use of lead arsenate was fully realized, it was the accepted standard method of control for codling moth, that almost universal pest of apples and pears. Studies on the life history and habits of the Oriental fruit moth made shortly after its discovery in this country revealed that the larva, although a biting and chewing form somewhat similar to that of the codling moth, has a habit of spitting out the first one or two mouthfuls of food and thus escapes the effects of the poison sprayed on the surface of the fruit or twig; hence in this case lead arsenate is not effective.

As is well known the fecundity of insects is remarkable. Taking the classic example of the ordinary vinegar fly as computed by LeFroy--if the offspring of a single pair lived for one year and none of the young died and none of the bodies decomposed, the total mass of ponderable material produced would bury the entire earth a million miles deep. Of course, there is nothing to worry about in this direction, because it never would happen. In the first place, comparatively speaking, almost all the offspring die and those that die do decay, so that there is no ponderable mass of sufficient size left to bury any part of the earth. Despite the fact that such a large proportion of the offspring of insects do die, however, there is a tremendous increase in the population of destructive insects from year to year. Notwithstanding these tremendous populations of insect pests from time to time which take a huge toll in crops and which spread disease and annoy human kind in other ways, there is no such thing as the insects of the world wiping out civilization. However, if crops and foods are to be produced in sufficient quantity for our needs and at a cost making it profitable to so produce, insects must be controlled. Control depends upon research; research means to study, get the facts.

The science of entomology is fighting insects on many fronts and every possible known advantage is being taken even to the use of insects against insects. The first importation of insect parasites into the United States was that of a wasp from England in 1883 to aid in the control of the cabbage worm. Since that date 403 species of insect parasites and predators have been imported from Europe, Africa, Australia, Japan, and other countries, and 73 of these have become established. When Koebele introduced the Vedalia into California and it cleaned up the cottony cushion scale, an insect which threatened the very existence of the citrus industry in that State, there was furnished an early and graphic example of the value of the use of beneficial insects. A beetle which feeds upon mealybugs was imported into the United States from Australia in 1891, and since that date has been distributed to 33 other countries. A parasitic wasp which is native to North America and which attacks the woolly apple aphid and brings it under control has been sent from the United States to 40 countries throughout the world since the first shipment to France in 1920. When at the suggestion of the officials of the Florida State Plant Board, Clausen was sent to Malaya to take parasites of the citrus blackfly to Cuba, the results were far-reaching and important. Not only did this action reduce the citrus blackfly in Cuba from a pest of first importance to minor rank, but also reduced the risk which had been present in marked degree of introduction of the pest into this country. Moreover it was a demonstration of far-sighted planning and of good neighborliness. The work now going on in the collection of beneficial insects, their exchange between nations, and their colonization and study certainly enter into the program of treating of insects.

It will thus be seen that along with the effort to destroy injurious forms of insects, opportunities have not been entirely overlooked to make more helpful to the human race beneficial insects; and among these of course one of the outstanding examples is the honey bee. Entomologists have determined that bees are more effective in gathering honey and pollinating plants if they can reach farther with their tongues into deeper flowers for the nectar. Hence an effort has been made with substantial progress in developing bees with longer tongues. Since bees in nature mate on the wing only, this recourse to the practice of eugenics in the bee family has been fraught with difficulty but has been successfully accomplished.

Notwithstanding these efforts we are told from time to time even by outstanding entomologists that in our zeal to control or kill injurious insect forms, we have too little regard for the well-being of the beneficial forms upon which we depend for pollination of plants and other useful functions. We are frequently told of the killing of colonies of bees through the use of sprays for the control of fruit

and crop pests, and we are consequently urged to have more regard for the life of the useful insects even though the injurious forms may in some instances do more harm. These warnings and admonitions are of course well meant and should be given every possible consideration. Of course there are as usual two sides to these arguments. A recent article in one of the leading bee publications referred to the warning given by entomologists of the possible grasshopper outbreak the coming season and indicated that grasshoppers were very abundant in most of the sweet clover regions the past season. It was pointed out that the sweet clover is one of the favorite honey plants for the honey bee and that the invasion of grasshoppers might well prove serious to the beekeeper since sweet clover is attractive to the grasshoppers as a food and is the sole source of surplus honey in a large area. Of course, the obvious answer there is to heed this particular warning and poison the grasshoppers to save the food for the bees, but since grasshoppers can be poisoned with a material which is not attractive to the bees, there can be no argument as to what should be done.

It is necessary to treat of insects when controlling and eradicating many of the plant diseases. The Dutch elm disease introduced from abroad and now constituting a serious threat to the elms of this country, is spread by at least two insects and possibly by more. Sugar-cane mosaic is carried by insects. The most important disease of sugar beets, curly top, is spread by leafhoppers. It is suspected that phony disease of the peach may be spread by insects although definite information on this point is lacking. It has recently been found that peach yellows is spread by an insect vector, and no doubt insects enter into the general program of plant disease spread and control more than we know. Insects themselves are affected by diseases and attempts are being made to develop and culture the diseases with a view to using them in the fight against injurious insects.

Treating of insects through studies of plant resistance has its place in the picture. Man is limited in his consumption of many members of the plant kingdom because of their bad taste, poor quality as food, fibrous composition, poisonous character, or possibly even because they present an unattractive appearance. Investigations by entomologists have revealed that insects such as the Hessian fly also have food preferences and limitations in selection of varieties of wheat or even the individual wheat plants for food. Some plants are entirely unsuited for the support of the flies, even when the variety is generally suitable, and parent flies selecting such plants for egg laying doom their offspring to an early death. Other plants may be quite unattractive for egg laying and thus escape infestation. Study of these food and egg-laying peculiarities of the Hessian fly and of other species of insects has indicated the possibility of developing resistant strains of plants entirely suitable for human or livestock consumption but immune or partially immune to insect attack.

In the chemistry of developing insecticides and fungicides it is essential to treat of insects. Knowledge of the insect habits, the methods of fighting, and the character of injury is an essential part of the chemist's approach to the problem of developing a killer. Fungicides must be compatible with insecticides, and vice versa; hence plant diseases must be taken into account. No more attentive listeners will be found at entomological meetings than the chemists of the Division of Insecticide Investigations in the Bureau of Entomology and Plant Quarantine.

In studying and fighting insects it must be remembered that many of the most injurious forms spend a large portion of their lifetime in the ground as larvae or worms. The Japanese beetle, for example, a serious pest on the Atlantic Seaboard, spends nine months of the year in the soil as a larva. Many of the wireworms are in the soil three years in the worm stage and, as is well known, the periodical cicada spends seventeen years in the soil. Entomologists are thus dealing with species which are not able to give expression to the reaction of the various insecticides and other control measures used and observations are difficult and necessarily infrequent. So when entomologists are asked why after many years of study on a certain insect they are not able to immediately outline adequate control measures, there is a real answer. And at that the progress made probably does not suffer in comparison with the progress made by other branches of science in the study, for example, of many human ailments, even that most ordinary thing the common cold.

Conservation of natural resources involves treating of insects and to a far greater degree than is now practiced if it is to be real conservation. You may find thousands of square miles of forested areas in this country where the best of the timber has been killed by insects. In large areas in the high forests of the West the losses occasioned by insects exceed the combined value of timber cut for lumber and burned by fire. Does this suggest treating of insects? Our range lands are denuded over large areas by the feeding of grasshoppers and Mormon crickets. Not only do we lose the range but an erosion problem is created. Does not real conservation suggest something here? What about the conservation of animals? Consider the fever tick, the buffalo gnat, the screw worm, the insects that prey on wildlife. How about the health of humans? What of yellow fever, malaria, spotted fever, tularemia, all transmitted by insects; and consider for just a moment merely the comfort of humans; is it not affected by the housefly, the mosquito, the sandfly, or the eye gnat, not to mention other forms not usually mentioned above a whisper? Think of the furs, the clothing destroyed by clothes moths, the furniture destroyed by carpet beetles, and the furniture and buildings wrecked by termites. Does not all this suggest some of the reasons for the treating of insects?

Treating of insects includes also consideration of their distribution and spread. Man by his means of communication and desire for products, plants and materials found in other sections, has provided many ways to spread insects into new areas. Examples of this are numerous; that there are not more of them is surprising. But the entomologist has not overlooked the importance of this and the serious consequences that may arise if no restrictions are imposed. It has been the entomologist who was, and still is, the prime mover in the establishment and enforcement of laws and regulations to prevent the spread of plant pests. This has led to the development of another specialized field in this science of treating insects, a field touching many activities, at home and abroad; activities which affect the commerce of the country and the world, requiring the examination of ships entering our ports, inspection and treatment of products, fumigation of railway cars; and many others too numerous to mention. Specialization in this phase of the work of treating of insects, one of the newer aspects of the science, has come into importance so recently that its principles and fundamentals receive only inadequate consideration in the preparatory instructions offered by many schools of higher learning. This, despite the fact that the work of quarantine is carried on by Federal and state forces in as close cooperation as any work in the treating of insects that can be mentioned.

What facilities are available for treating of insects? In the Bureau of Entomology and Plant Quarantine research work on insects is going on outside of Washington and outside of the National Agricultural Research Center at Beltsville, at 92 stations in 34 states, and at any one station several divisions of the Bureau may be located, as for example, Orlando, Fla. Research work including parasite studies is also going on at stations in Hawaii, Puerto Rico, the Canal Zone, France, and Japan. Quarantine and control work is being carried on at 166 permanent stations in 41 states and in Hawaii and Puerto Rico. These are manned by permanent employees and do not take into account the large number of seasonal or temporary employees used in various features of the work.

When entomological work in the United States Department of Agriculture attained the status of a bureau July 1, 1904, the appropriation was $82,450. This fiscal year it is $5,317,675 with 1,621 permanent employees. In addition there have been made available during the past year $12,000,000 emergency funds, and last summer the peak employment figure was twenty-seven thousand people on pest control projects paid with emergency funds exclusive of regular appropriations.

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